**GDAŃSK UNIVERSITY
OF TECHNOLOGY**

Subject card

Subject name and code	Heat flows, PG_00051075		
Field of study	Technical Physics		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	6	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment

Conducting unit	Instytut Fizyki i Informatyki Stosowanej -> Faculty of Applied Physics and Mathematics	
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Sebastian Bielski
	Teachers	dr inż. Sebastian Bielski

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	15.0	0.0	60
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	60	5.0	35.0	100

Subject objectives	Presentation of knowledge concerning the heat transfer mechanisms. Application of analytical and numerical methods to solve the heat conduction problems.
Learning outcomes	

Course outcome	Subject outcome	Method of verification
K6_W02	Students explain the definitions of quantities and laws used in the analysis of heat conduction, convection and thermal radiation.	[SW1] Assessment of factual knowledge
K6_U02	Students uses analytical and numerical (Matlab) methods to solve heat conduction problems.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools

<table>
<tr><td>Subject contents</td><td>Lecture:
1. Preliminaries.
1.1. Definitions.
1.2. Heat transfer mechanisms: conduction, convection, thermal radiation.
1.3. Quantities and laws describing the heat transfer: conduction, Newton"s law of cooling, radiation.
2. Equations describing the heat transfer.
2.1. Thermal conductivity.
2.2. The temperature field.
2.3. The heat equation.
2.4. Boundary conditions.
3. Stationary heat conduction with no heat sources.
3.1. 1-dimensional case.
3.2. Multilayered walls.
3.3. 2-dimensional case.
4. Stationary heat conduction with heat sources.
4.1. The heat equation in case of the presence of the heat sources.
4.2. 1-dimensional cases of the heat conduction.
5. Non-stationary heat conduction.
5.1. Infinite wall.
5.2. A rod with insulated lateral surface.
5.3. Sphere.
5.4. Cylinder.
5.5. 2-dimensional case.
5.6. Non-stationary heat conduction in presence of the heat sources.
5.7. 1-dimensional cases, time-dependent boundary conditions.
5.8. The Pennes equation.
6. Convection
6.1. Continuity equation

6.2. Navier-Stokes equation

6.3. Energy equation
7. Thermal radiation.
7.1. Definitions.
7.2. Emissivity.
7.3. Heat transfer via radiation between two parallel surfaces.

Laboratory/Project: Solving stationary and non-stationary heat conduction problems.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>exam</td><td>50.0%</td><td>51.0%</td></tr>
<tr><td>semester project</td><td>50.0%</td><td>49.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>J. H. Lienhard, J. H. Lienhard, A heat transfer textbook, Phlogiston Press, Cambridge, 2004</td></tr>
<tr><td>Supplementary literature</td><td>M. Kaviany, Principles of heat transfer</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
Przepływy ciepła_23/24 - Moodle ID: 34972
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34972</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Describe the quantities that affect the heat transfer via radiation between two parallel surfaces.
2. Derive the heat diffusion equation.
3. How much energy is radiated each second by one square meter of the black body if the spectral radiance peaks at = 484 nm? a) E = 1.47 J; b) E = 1.47 kJ; c) E = 0.735 J; d) none of the values above.
4. Describe the 1-dimensional case of the heat conduction in case of constant heat generation rate.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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